AXL F BK EC

Axioline F bus coupler for EtherCAT®

Data sheet
8479_en_07

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1 Description

Valid from firmware version 1.10.

The bus coupler represents the link between an EtherCAT®network and the Axioline F system.

You can connect up to 63 Axioline F devices to an existing EtherCAT® system with the help of the bus coupler.

EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Auotmation GmbH, Germany.

EtherCAT® features

- 2 Ethernet-Ports
- Automatic addressing
- Rotary coding switch for assigning the ID for the “Explicit Device ID” mechanism
- Detail of the station as a modular EtherCAT® device using a Modular Device Profile (MDP)
- Detail of the station as a block device is possible
- Acyclic data communication (mailbox protocols)
- Cyclic (synchronous) data communication
  - Supports the EtherCAT® cycle time of < 100 µs
  - Synchronism between EtherCAT® and local bus
  - Distributed clocks (jitter << 1 µs) for specific data acquisition

Features of Axioline F

- Up to 63 additional Axioline F devices can be connected
- Typical cycle time of the Axioline F local bus is around 10 µs
- Runtime in the bus coupler is negligible (goes to 0 µs)
- Firmware can be updated
- Diagnostic and status indicators

Abbreviations used

CoE	CAN application layer over EtherCAT®
DC	Distributed clocks
FoE	File accesss over EtherCAT®

This data sheet is only valid in association with the UM EN AXL F SYS INST user manual.

Make sure you always use the latest documentation.
It can be downloaded from the product at phoenixcontact.net/products.

Here you will also find the current ESI file.

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3 Ordering data

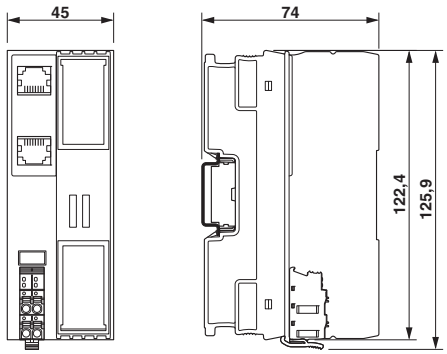
Description	Type	Order No.	Pcs. / Pkt.
Axioline F bus coupler for EtherCAT® (including bus base module and connector)	AXL F BK EC	2688899	1

Accessories	Type	Order No.	Pcs. / Pkt.
Axioline F bus base module for housing type BK (Replacement item)	AXL BS BK	2701422	5
Axioline F short power connector (for e.g., AXL F BK ...) (Replacement item)	AXL CN S/UL	2701421	5
RJ45 connector, shielded, with bend protection sleeve, 2 pieces, gray for straight cables, for assembly on site. For connections that are not crossed, it is recommended that you use the connector set with gray bend protection sleeve. (Connector/Adapter)	FL PLUG RJ45 GR/2	2744856	1
RJ45 connector, shielded, with bend protection sleeve, 2 pieces, green for crossed cables, for assembly on site. For connections that are crossed, it is recommended that the connector set with green bend protection sleeves is used. (Connector/Adapter)	FL PLUG RJ45 GN/2	2744571	1
Crimping pliers, for assembling the RJ45 plugs FL PLUG RJ45..., for assembly on site (Tools)	FL CRIMPTOOL	2744869	1
Zack marker strip for Axioline F (device labeling), in 2 x 20.3 mm pitch, unprinted, 25-section, for individual labeling with B-STIFT 0.8, X-PEN, or CMS-P1-PLOTTER (Marking)	ZB 20,3 AXL UNPRINTED	0829579	25
Zack marker strip, flat, in 10 mm pitch, unprinted, 10-section, for individual labeling with M-PEN 0,8, X-PEN, or CMS-P1-PLOTTER (Marking)	ZBF 10/5,8 AXL UNPRINTED	0829580	50
Insert label, Roll, white, unlabeled, can be labeled with: THERMOMARK ROLL, THERMOMARK X, THERMOMARK S1.1, Mounting type: snapped into marker carrier, Lettering field: 35 x 18.7 mm (Marking)	EMT (35X18,7)R	0801831	1

Documentation	Type	Order No.	Pcs. / Pkt.
User manual, English, Starting up the Axioline F bus coupler for EtherCAT® using TwinCAT®	UM EN AXL F BK EC	-	-
User manual, English, Axioline F: System and installation	UM EN AXL F SYS INST	-	-
User manual, English, Axioline F: Diagnostic registers, and error messages	UM EN AXL F SYS DIAG	-	-
User manual, English, AXL F BK EC bus coupler: Access to PDI objects and startup parameterization	AH EN AXL F BK EC - TUNNEL	-	-
Application note, English, Firmware update on the AXL F BK EC bus coupler with TwinCAT®	AH EN FIRMWARE UPDATE AXL F BK EC	-	-

4 Technical data

Dimensions (nominal sizes in mm)



Width	45 mm
Height	125.9 mm
Depth	74 mm
Note on dimensions	The depth is valid when a TH 35-7.5 DIN rail is used (according to EN 60715).

General data

Color	traffic grey A RAL 7042
Weight	177 g (with connector and bus base module)
Ambient temperature (operation)	-25 °C ... 60 °C (Mounting position: wall mounting on horizontal DIN rail) -25 °C ... 55 °C (Mounting position: any)
Ambient temperature (storage/transport)	-40 °C ... 85 °C
Permissible humidity (operation)	5 % ... 95 % (non-condensing)
Permissible humidity (storage/transport)	5 % ... 95 % (non-condensing)
Air pressure (operation)	70 kPa ... 106 kPa (up to 3000 m above sea level)
Air pressure (storage/transport)	70 kPa ... 106 kPa (up to 3000 m above sea level)
Degree of protection	IP20
Protection class	III, IEC 61140, EN 61140, VDE 0140-1
Mounting position	Any (observe temperature derating)

Connection data

Designation	Axioline F connector
Connection method	Push-in technology
Conductor cross section solid / stranded	0.2 mm² ... 1.5 mm² / 0.2 mm² ... 1.5 mm²
Conductor cross section [AWG]	24 ... 16
Stripping length	8 mm

Interface EtherCAT®

Number	2
Connection method	RJ45 socket, auto negotiation and autocrossing
Transmission speed	100 MBit/s (Full duplex)
Cycle Time	100 µs
Transmission physics	Ethernet in RJ45 twisted pair
Transmission length	max. 100 m

Interface Axioline F local bus

Connection method	Bus base module
Transmission speed	100 MBit/s

Interface Service

Number	1
Connection method	Micro USB type B

System limits

Amount of process data	1024 Byte (for each data direction)
Number of supported devices	max. 63 (per station)

NOTE: Electronics may be damaged when overloaded

Observe the logic current consumption of each device when configuring an Axioline F station. It is specified in every module-specific data sheet. The current consumption can differ depending on the individual module. The permissible number of devices that can be connected therefore depends on the specific station structure.

EtherCAT®

Mailbox protocols	CAN application layer over EtherCAT®, File access over EtherCAT®
Type of addressing	Auto-increment addressing Fixed position addressing Logical addressing Explicit device ID
Specification	ETG.1000 V1.02

Supply of the bus coupler

Supply of communications power U_L	24 V DC
Maximum permissible voltage range	19.2 V DC ... 30 V DC (including all tolerances, including ripple)
Current supply at U_{Bus}	2 A
Current consumption from U_L	typ. 105 mA (without I/Os and U_L = 24 V) max. 570 mA (with 2 A at U_{Bus} for the I/Os and U_L = 24 V)
Power consumption at U_L	typ. 2.5 W (without I/Os) max. 13.7 W (with 2 A load at U_{Bus} for the I/Os)

NOTE: Electronics may be damaged when overloaded

Provide external fuses for the 24 V U_L area. The power supply unit must be able to supply four times the nominal current of the external fuse to ensure that it blows in the event of an error.

Error messages to the higher level control or computer system

Emergency messages	
Messages via object $10F3_{hex}$ Diagnosis history	

Mechanical tests

Vibration resistance in acc. with EN 60068-2-6/IEC 60068-2-6	5g
Shock in acc. with EN 60068-2-27/IEC 60068-2-27	30g
Continuous shock according to EN 60068-2-27/IEC 60068-2-27	10g

Conformance with EMC Directive 2004/108/EC

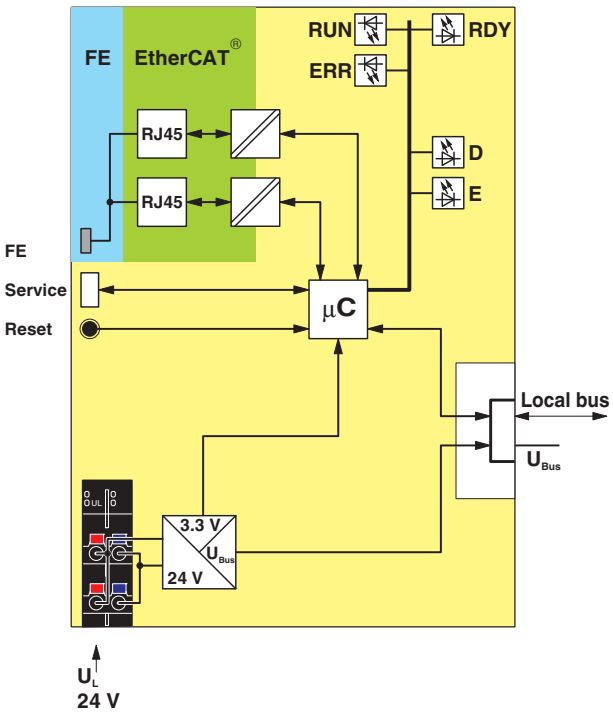
Noise immunity test in accordance with EN 61000-6-2	
Electrostatic discharge (ESD) EN 61000–4–2/IEC 61000–4–2	Criterion B; 6 kV contact discharge, 8 kV air discharge
Electromagnetic fields EN 61000–4–3/IEC 61000–4–3	Criterion A; Field intensity: 10 V/m
Fast transients (burst) EN 61000–4–4/IEC 61000–4–4	Criterion B, 2 kV
Transient surge voltage (surge) EN 61000–4–5/IEC 61000–4–5	Criterion B; DC supply lines: ±0.5 kV/±0.5 kV (symmetrical/asymmetrical); field-bus cable shield: ±1 kV

Conformance with EMC Directive 2004/108/EC	
Conducted interference EN 61000–4–6/IEC 61000–4–6	Criterion A; Test voltage 10 V
Noise emission test according to EN 61000-6-3	
Radio interference properties EN 55022	Class B

Approvals

For the latest approvals, please visit phoenixcontact.net/products.

5 Internal circuit diagram



Key:

FE	Functional earth ground
Service	Service interface
Reset	Reset button
Local bus	Axioline F local bus (hereinafter referred to as local bus)
RJ45	RJ45 interface
	Power supply unit with electrical isolation
µC	Microcontroller
	Power supply unit
	LED
	Electrically isolated areas

Figure 1 Internal wiring of the terminal points

6 Connecting EtherCAT® and supply

6.1 Connecting EtherCAT®

Connect EtherCAT® to the bus coupler via an 8-pos. RJ45 connector.

The EtherCAT® connections are directional.

Designation	Direction	Note
X1	IN	Connecting the cable from the master.
X2	OUT	

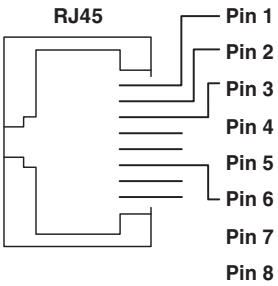


Figure 2 Pin assignment of the Ethernet socket (RJ45)

For the pin assignment, please refer to the following table:

Pin	Assignment
1	TxD + (transmit data +)
2	TxD - (transmit data -)
3	RxD+ (receive data +)
4	Reserved
5	Reserved
6	RxD- (receive data -)
7	Reserved
8	Reserved

Auto crossover
Both Ethernet interfaces are provided with the auto crossover function.

Shielding
The shielding ground of the connected twisted pair cables is electrically connected with the socket. When connecting network segments, avoid ground loops, potential transfers, and voltage equalization currents via the braided shield.

Observe bending radii
The housing dimensions specified under "Dimensions" refer to the bus coupler with I/O connectors without Ethernet connection. When installing the bus coupler in a control box, observe the bending radii of the Ethernet cables and the connectors used (e.g., FL CAT5 FLEX: 30 mm for fixed installation and FL CAT5 HEAVY: 30 mm without outer sheath and 45 mm with outer sheath). If required, use angled RJ45 connectors to maintain these bending radii.

6.2 Connecting the supply voltage - terminal point assignment

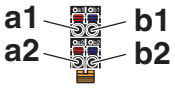


Figure 3 Terminal point assignment

Terminal point	Color	Assignment	
Supply voltage input			
a1, a2	Red	24 V DC (U_L)	Supply of the logic voltage (internally jumpered)
b1, b2	Blue	GND	Reference potential of the supply voltage (internally jumpered)

7 Connection example

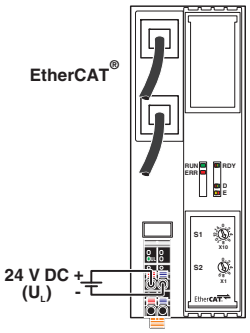


Figure 4 Connection of the cables

8 Configuration via rotary encoding switch

You can configure the address assignment using the rotary coding switch.

After modifying the switch position, restart the bus coupler, as the modification to the switch position does not take effect during operation.

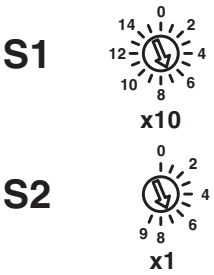


Figure 5 Rotary encoding switch

The code results from the sum of S1 x 10 plus S2 x 1. The image shows code 77 (7 x 10 + 7).

S1	S2	Code	Function
0 ... 15	1 ... 9	01 ... 159	Device Identification Value
Other			Reserved

8.1 Device identification value

Switch position 01 ... 159

The devices are automatically assigned addresses as standard.

Set the EtherCAT® explicit device identification manually with this switch position.

8.2 Reserved/invalid switch position

The device starts with the previous settings, e.g., with the settings that were valid before the device was restarted.

9 Local status and diagnostic indicators

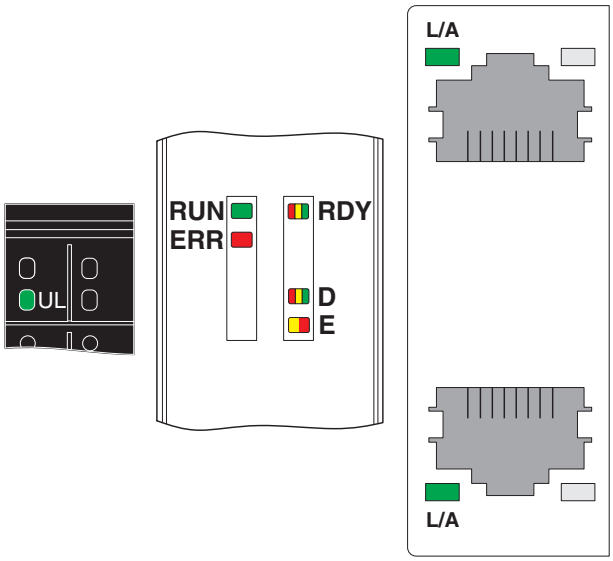


Figure 6 Local status and diagnostic indicators

Designation	Color	Meaning	State	Description
UL	Green	**U**$_{Logic}$	ON	Communications power supply present.
			OFF	Communications power supply not present.
RUN	Green	RUN	OFF	Bus coupler in Init state
			Flashing slowly (2.5 Hz)	Bus coupler in Pre-Operational state
			Single pulse	200 ms on, 1000 ms off; bus coupler in Safe-Operational state
			ON	Bus coupler in Operational state
			Flashing (10 Hz)	Bus coupler in Bootstrap state
ERR	Red	**Err**or	OFF	No error
			Flashing slowly (2.5 Hz)	Configuration error; a state transition initiated by the master cannot be executed
			Single pulse	200 ms on, 1000 ms off; local application error
			Double pulse	200 ms on, 200 ms off, 200 ms on, 1000 ms off; watchdog timeout
			ON	Critical internal error
RDY	Green/ yellow/ red	**Ready**	Green ON	Device is ready for operation.
			Flashing green/yellow	Communications power undervoltage or surge voltage
				Overtemperature
			Yellow ON	Firmware/bus coupler is booting
			Yellow flash-ing	Firmware update is being performed.
			Yellow/red	Firmware update has failed.
			Red ON	Rotary encoding switches are set to an invalid/reserved position
			OFF	Device is not ready to operate.

Designation	Color	Meaning	State	Description
D	Green/ yellow/ red	**D**iagnostics	Green ON	Run: Data exchange; status and data from the higher-level system is transmitted.
			Green flashing	Active: configuration is active, data exchange with invalid process data, PDI channel can be used.
			Yellow ON	Ready: Device is ready to operate, no data is exchanged.
			Yellow flashing	Access from Startup+ in I/O check mode
			Flashing yellow/red	Bus error during active I/O check
			Red flashing	Local bus error on startup
			Red ON	General local bus error
				Communication error
				Local bus device has been removed or configured device is missing.
				Reset at a local bus device
				Serious device error at a local bus device (local bus device can no longer be reached)
E	Yellow/ red	**E**rror	Yellow ON	I/O warning at a local bus device
			Red ON	I/O error at a local bus device
L/A	Green	**L**ink/**A**ctivity	Green ON	Connection present at EC IN/EC OUT.
			Green flashing	Transmission or reception of Ethernet telegrams at EC IN / EC OUT.
			OFF	Connection not present at EC IN/EC OUT.

10 Reset button

The reset button is located beneath the top marking label on the bus coupler.

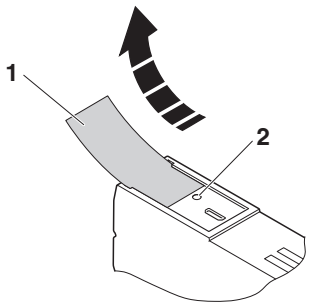


Figure 7 Reset button

1 Labeling field
2 Reset button

The reset button has the following functions:

– Restarting the bus coupler
– Resetting of the default settings

10.1 Restarting the bus coupler

The bus coupler is restarted when the button is pressed during operation.

The outputs of the station are set to the parameterized substitute values.

The process image of the inputs is not re-read.

10.2 Restoring the default settings

If you wish to restore the default settings, proceed as follows:

- Disconnect the power to the module.
- Press and hold the reset button.
- Switch on the power.
- When the RDY LED flashes red/green, release the button.

During the reset process the RDY LED lights up yellow.

When the bus coupler is fully started and ready to operate, the RDY LED lights up green.

11 Service interface

The service interface is located beneath the top marking field on the bus coupler.

The service interface is used for later applications.

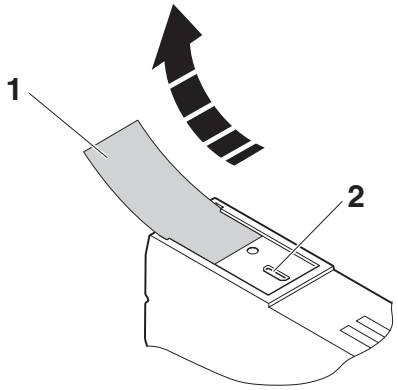


Figure 8 Service interface

1 Labeling field
2 Service interface

12 Parameter data

The CAN application layer over EtherCAT® (CoE) mailbox protocol is the basis of the Modular Device Profile and enables parameterization of EtherCAT® devices via the object dictionary. The object dictionary is accessed via COE using Service Data Object (SDO) services.

Axioline F modules are parameterized via objects intended for this purpose in the CoE object dictionary. Each Axioline F module has two tunnel objects, via which the parameters can be set (object $20nn_{hex}$) and read (object $30nn_{hex}$). These tunnel objects can be used to parameterize the Axioline F modules in EtherCAT® system startup via the EtherCAT® engineering functionality of the StartUp or Init commands.

In the event of an error in the local bus, you can parameterize whether the local bus continues to run in the remaining system or whether it enters the stop state.

The objects implemented on the bus coupler are described in the "Object dictionary" section.

13 Substitute value behavior

If EtherCAT® communication fails or an error occurs in the local bus, all Axioline F station outputs are set to the parameterized substitute values.

14 Synchronizing the application

There are two modes for synchronizing the application which can be selected in the engineering system.

1. SM Synchronous
2. DC Synchronous

14.1 SM Synchronous

In this mode, the EtherCAT® communication system and the local bus operate asynchronously. The local bus is in Auto-Run mode and runs with the minimum possible cycle time for the current module configuration.

14.2 DC Synchronous

In this mode, the bus cycle of the local bus is synchronized to the EtherCAT® cycle.

The implemented distributed clock unit is used to synchronize the processes in a temporal manner.

If you want to use the DC Synchronous mode of the bus coupler, make sure that there is at least one module in the Axioline F station that supports local bus synchronization.

If you set DC Synchronous mode and there is no module in the Axioline F station that supports local bus synchronization, the bus coupler refuses the change in state from PRE-OP to SAFE-OP with AL status code 0028_{hex} (SyncMode not supported).

The LEDs indicate this state:

LED	State	Meaning
Bus coupler		
RUN	Flashing slowly (2.5 Hz)	Bus coupler in Pre-Operational state
ERR	Flashing slowly (2.5 Hz)	Configuration error; a state transition initiated by the master cannot be executed
D	Green flashing	Active: configuration is active, data exchange with invalid process data, PDI channel can be used.
Local bus device		
D	Green flashing	Active

Implementing DC Synchronous mode

In synchronous operation, the time points for outputting and reading process data from the individual I/O modules of the Axioline F station are synchronized with the higher-level network. This synchronization is by means of EtherCAT® Distributed Clocks (DC).
A requirement for this is that bus-synchronous operation is supported by the module. All modules that do not support bus-synchronous operation continue running asynchronously, as in SM Synchronous mode.
For information on which modules support bus-synchronous operation and the minimum cycle time that is possible, please refer to the module-specific documentation.

In general, with a preselected DC cycle time, only the I/O modules whose update rate (plus local bus cycle time) is less than the DC cycle time are operated synchronously. Only then do these I/O modules supply a new value in every DC cycle.

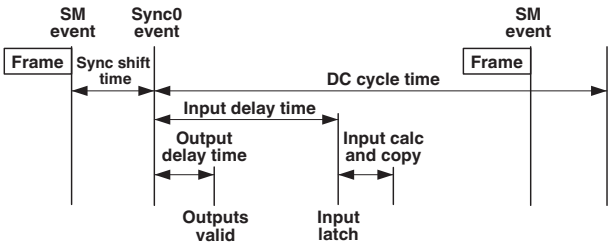


Figure 9 Synchronization model

The figure shows the synchronization model of the Axioline F bus coupler for EtherCAT®.
The so-called “DC Sync0 event” is used for synchronization. After the “Sync0 event” has occurred and a fixed delay time (output delay time) has elapsed, the process data is output. The inputs are likewise read after a fixed delay (input delay time).
The delay times depend on the Axioline F modules used as well as the size of the Axioline F station. They are calculated by the bus coupler during startup and are then constant.

Please observe the following when parameterizing the bus coupler for operation in DC Synchronous mode:

Select “Sync shift time”, i.e., the interval between “SM event” and “Sync0 event”, between 10% and 30% of the cycle time as far as possible.

The shortest EtherCAT® bus cycle must not be shorter than the maximum synchronization time of the modules located in the local bus that can be synchronized.

Object $F102_{hex}$ can be used to specify which modules of the local bus operate bus-synchronously (see “Objects for the status of bus-synchronous operation”).

15 Object dictionary

The bus coupler object dictionary contains objects which can be addressed via SDO services. These are defined in the ETG standards. Objects with a module-specific design are subsequently described in detail.

The objects are addressed using a combination of index and subindex. Subindex 0 lists the number of subindices.

The following applies for the tables below:

Length	Length of the elements in bytes
Rights	Access rights
R	Read
W	Write
nn	Module number in an Axioline F station, beginning with 01

15.1 CoE standard objects

Index (hex)	Name	Defined in standard
1000	Device type	ETG.1000.6
1008	Device name	ETG.1000.6
1009	HardwareVersion	ETG.1000.6
100A	Software Version	ETG.1000.6
1018	Identify	ETG.1000.6
10F1	Error settings	ETG.1020
10F3	Diagnosis history	ETG.1020
10F8	Timestamp	ETG.1020
1C00	SyncManager type	ETG.1000.6
1C12	RxPDO assign	ETG.1000.6
1C13	TxPDO assign	ETG.1000.6
1C32	SM output parameter	ETG.1020
1C33	SM input parameter	ETG.1020
F000	Modular device profile	ETG.5000.1
F030	Configured module ident list	ETG.5000.1
F050	Detected module ident list	ETG.5000.1

ETG.1000.6	Application Layer protocol specification
ETG.1020	EtherCAT® Protocol Enhancements
ETG.5000.1	Modular Device Profile Part 1

15.2 Module-specific CoE objects

In the table below, nn is the number of the module that is to be addressed. The numbering starts with 01.

Index (hex)	Sub-index	Object name	Data type	Length	Rights	Meaning	
6nn0	01	Inputs	Octet string	Depending on module	R	nn module input process data	
7nn0	01	Outputs	Octet string	Depending on module	R	nn module output process data	
16nn	01	RxPDO mapping		4	R	Bit 31 ... 16	Index of the associated input data object (e.g., 6010_{hex})
						Bit 15 ... 8	Subindex of the associated input data object
						Bit 7 ... 0	Subindex length of the associated input data object
1Ann	01	TxPDO mapping		4	R	Bit 31 ... 16	Index of the associated output data object (e.g., 7010_{hex})
						Bit 15 ... 8	Subindex of the associated output data object
						Bit 7 ... 0	Subindex length of the associated output data object
9nn0		Module nn identification	Record			Identification of module nn	E.g., module 1: 9010_{hex}, module 2: 9020_{hex} etc.
	0A	Module ident	Unsigned 32	4	R	Unique number for module identification (connection to device description)	
	0B	Slot	Unsigned 16	2	R	Location of the module in the Axioline F station, beginning with 1	
Ann0		DiagState	Record			Diagnostics	Read access to PDI object 0018_{hex} in the Axioline F nn module via the PDI channel
	01	No	Unsigned 16	2	R	Error number	See data sheet on the module.
	02	Prio	Unsigned 8	1	R	Priority	See data sheet on the module.
	03	Channel/group/module	Unsigned 8	1	R	Channel/group/module	See data sheet on the module.
	04	Code	Unsigned 16	2	R	Error code	See data sheet on the module.
	05	MoreFollows	Unsigned 8	1	R	More follows	See data sheet on the module.
	06	Text	Visible String	51	R	Text	See data sheet on the module.

15.3 CoE objects for identification (device rating plate)

PDI objects are stored on each Axioline F module for identification purposes. They contain information about the manufacturer and module and make up the device rating plate.

This information can be accessed using the bus coupler via EtherCAT®.

The following tables describe the detail on the device rating plate on objects in EtherCAT®.

Detail of manufacturer-specific information

Index (hex)	Sub-index	Object name	Data type	Length	Rights	Meaning (code in hex)	
9nn1		Manufacturer information				Detail of manufacturer-specific information from the PDI objects for identification (device rating plate)	
	01	VendorName	Visible String	15	R	0001	Vendor name
	02	Vendor ID	Visible String	6	R	0002	Vendor ID
	03	VendorText	Visible String	48	R	0003	Vendor text
	04	VendorURL	Visible String	29	R	0012	Vendor URL

Detail of module-specific information

Index (hex)	Sub-index	Object name	Data type	Length	Rights	Meaning (code in hex)	
9nn2		Information on module				Detail of module-specific information from the PDI objects for identification (device rating plate)	
	01	ProductName	Visible String	Max. 58	R	0007	Product name
	02	Serial number	Visible String	11	R	0008	Serial number
	03	ProductText	Visible String	Max. 58	R	0009	Product text
	04	OrderNumber	Visible String	8	R	000A	Order No.
	05	HW BuildDate	Visible String	10	R	000B.1	Hardware version, date of version
	06	HW Version	Visible String	Max. 40	R	000B.2	Hardware version, version ID
	07	FW BuildDate	Visible String	10	R	000C.1	Firmware version, date of version
	08	FW Version	Visible String	Max. 40	R	000C.2	Firmware version, version ID
	09	PDI BuildDate	Visible String	10	R	000D.1	Parameter channel version, date of version
	0A	PDI Version	Visible String	Max. 40	R	000D.2	Parameter channel version, version ID
	0B	DeviceType	Octet string	8	R	0037	Module identification

15.4 Objects for access to PDI objects (tunnel objects)

Parameter and diagnostic data as well as other information is transmitted via the PDI channel of the Axioline F station.

You can access the PDI objects of the modules of a station via EtherCAT®. Objects $20nn_{hex}$ and $30nn_{hex}$ are used, with which a tunnel method can be implemented.

Index (hex)	Sub-index	Object name	Data type	Length	Rights	Meaning	
20nn		Axioline F module nn PDI write tunnel object	Record			Write access to the PDI objects in Axioline F module nn via the PDI channel Mapping to PDI write service (service code 01_{hex}) at slot nn	
	01	Command	Octet string	250	R/W	Data for the PDI write request	
						Byte 0	Subslot
						Byte 1, 2	PDI object index
						Byte 3	PDI object subindex
						Byte 4	Length of the data to be written
						Byte 5 ... n	User data (max. 245 bytes)
	02	Status	Unsigned 8	1	R	Status of the last write access	
						01_{hex}	Last access completed successfully (positive confirmation received)
						03_{hex}	Last access not completed successfully (negative confirmation received)
	03	Response	Octet string	9	R	Result of the last write access Data for PDI write response	
						Byte 0	Subslot
						Byte 1, 2	PDI object index
						Byte 3	PDI object subindex
						Byte 4	Length (= 0)
						Positive confirmation	
						Byte 5 ... 8	0
						Negative confirmation	
						Byte 5	Error class
						Byte 6	Error code
						Byte 7, 8	Additional error code

Index (hex)	Sub-index	Object name	Data type	Length	Rights	Meaning	
30nn		Axioline F module nn PDI read tunnel	Record			Read access to PDI objects in Axioline F module nn via the PDI channel Mapping to PDI read service (service code 00_{hex}) at slot nn	
	01	Command	Octet string	4	R/W	Data for PDI read request	
						Byte 0	Subslot
						Byte 1, 2	PDI object index
						Byte 3	PDI object subindex
	02	Status	Unsigned 8	1	R	Status of the last read access	
						01_{hex}	Last access completed successfully (positive confirmation received)
						03_{hex}	Last access not completed successfully (negative confirmation received)
	03	Response	Octet string	250	R	Result of the last read access Data for PDI read response	
						Byte 0	Subslot
						Byte 1, 2	PDI object index
						Byte 3	PDI object subindex
						Byte 4	Length
						Positive confirmation	
						Byte 5, 6	0
						Byte 7 ... n	Data for PDI read response
						Negative confirmation	
						Byte 5	Error class
						Byte 6	Error code
						Byte 7, 8	Additional error code

15.5 Objects for Axioline F bus diagnostics

CoE object $F100_{hex}$ can be used to request the status information of the Axioline F master.

Index (hex)	Sub-index	Object name	Data type	Length	Rights	Meaning
F100		Axioline Bus Coupler Diag Info	Record			Read access to diagnostic information of the Axioline F master
	01	Axioline Bus State	Unsigned 16	2	R	Current state of the Axioline F local bus
	02	Axioline Error_Code	Unsigned 16	2	R	Error code according to the current bus state
	03	Axioline Add_Error Info	Unsigned 16	2	R	Additional error information

“Axioline Bus State” mirrors the diagnostic status register. For more detailed information on this, please refer to the UM EN AXL F SYS DIAG user manual.

“Axioline Error_Code” indicates the error code of module errors. For the meaning of the error code, please refer to the data sheet for the module in question or the UM EN AXL F SYS DIAG user manual.

“Axioline Add_Error Info” indicates the position of the module in question.

The data for object $F100_{hex}$ is additionally provided in the cyclic input data of the Axioline F station (see also “Process data of the bus coupler”).

15.6 Objects for the status of bus-synchronous operation

This object contains information about which local bus modules operate bus-synchronously.

Index (hex)	Sub-index	Object name	Data type	Length	Rights	Meaning
F102		Axioline modules used for synchronization	Record			During operation in DC Synchronous mode, indicates which Axioline F modules are operated bus-synchronously
	01		Unsigned 8	1	R	Position of the modules that are operated bus-synchronously in the local bus starting with 1; n ≤ 63
	...		Unsigned 8	1	R	
	n		Unsigned 8	1	R	

15.7 Objects for bus coupler configuration

The bus coupler has objects which are used for the configuration of the bus coupler. Write access to these objects is only possible in the PREOP state.

The contents of the objects are stored retentively in the bus coupler and are therefore still available after the bus coupler is restarted.

When reset to the default settings, these objects return to their default values.

Object $F800_{hex}$ can be used to configure the byte sequence of the transmitted process data.

Index (hex)	Sub-index	Object name	Data type	Length	Rights	Meaning	
F800		Endian settings	Record			Byte sequence setting for a process data length of 16, 32 or 64 bits. The EtherCAT® standard specifies Little Endian format, Axioline F uses Big Endian.	
	01	Swap Word	Bit	1	R	Byte sequence for a process data length of 16 bits	
						True	Little endian (default)
						False	Big endian
	02	Swap DWord	Bit	2	R	Byte sequence for a process data length of 32 bits	
						True	Little endian (default)
						False	Big endian
	03	Swap LWord	Bit	2	R	Byte sequence for a process data length of 64 bits	
						True	Little endian (default)
						False	Big endian

Object $F801_{hex}$ can be used to specify the bus coupler response in the event of a bus error.

Index (hex)	Sub-index	Object name	Data type	Length	Rights	Meaning	
F801		Leave OP on Axioline busfail	Record			Parameterization of the response to an Axioline F bus error	
	00		Bit	0.1	W		
						True	In the event of an Axioline F bus error, the bus coupler switches to the SAFEOP ERR state, in addition a diagnosis is entered.
						False	(default) In the event of an Axioline F bus error, the bus coupler remains in the OP state, only a diagnosis is entered.

Object $F802_{hex}$ can be used to check the connected module configuration.

Index (hex)	Sub-index	Object name	Data type	Length	Rights	Meaning	
F802		Validate module configuration	Record			Validation of the module configuration	
	00		Bit	0.1	W	True	(default) During the transition from PREOP to SAFEOP, the bus coupler checks the module configuration.
						False	The bus coupler does not check the module configuration.

In order for the module configuration to be checked, the master must write object F030hex with the expected module configuration during the state transition from PREOP to SAFEOP. If this is not done, validation is not carried out. When the object is written, it must be done so correctly and consistently. The contents of object F030 are reset on a state transition from SAFEOP to PREOP.

By writing to object $F803_{hex}$, the cycle time of the Axioline F local bus can be changed.

Index (hex)	Sub-index	Object name	Data type	Length	Rights	Meaning
F803		Axioline F bus cycle time	Record			Current Axioline F bus cycle time in nanoseconds
	00		Unsigned 32	4	R	Current bus cycle time in nanoseconds
					W	Changing the bus cycle time 0: sets the minimum possible cycle time

16 Process data

16.1 Process data of the bus coupler

In addition to the cyclic IN and OUT process data, which is defined by the connected Axioline F modules, the bus coupler itself has data which is inserted in the cyclic process image. This data has a total length of 8 bytes.

In accordance with the EtherCAT® standard, this data appears before the IN process data of the first Axioline F module in the process image (SyncManager 3 bytes 0 ... 8). The objects for the corresponding PDO mapping can be found in $1AFF_{hex}$.

Process data byte 0 and 1 (word 0) are assigned the “New diag massage bit” (index $10F3_{hex}$, subindex 04) of the “Diagnosis history” object.

Process data words 1 ... 3 contain status and diagnostic information for the Axioline F bus coupler and can also be called via acyclic services using CoE. They appear in the form of object $F100_{hex}$.

Word 0, byte 0							
7	6	5	4	3	2	1	0
							New Diagnosis Message

Word 0, byte 1							
7	6	5	4	3	2	1	0

Word 1	
Byte 3	Byte 2
Axioline bus state	

Word 2	
Byte 5	Byte 4
Axioline Error_Code	

Word 3	
Byte 7	Byte 6
Axioline Add_Error Info	

“Axioline Bus State” mirrors the diagnostic status register. For more detailed information on this, please refer to the UM EN AXL F SYS DIAG user manual.

“Axioline Error_Code” indicates the error code of module errors. For the meaning of the error code, please refer to the data sheet for the module in question or the UM EN AXL F SYS DIAG user manual.

“Axioline Add_Error Info” indicates the position of the module in question.

16.2 Process data of the local bus modules

The IN and OUT process data of the modules appear according to their process data description (PDI objects $003B_{hex}$ and $003C_{hex}$ on the module).

For mapping, object $F800_{hex}$ can be used to configure whether process data with a length of 16, 32, and 64 bits is to be transmitted in Big Endian format (Axioline F standard) or in Little Endian format. The configuration is stored retentively in the bus coupler.

17 Diagnostics strategy

17.1 Mechanisms

Different mechanisms are used to diagnose the bus coupler.

Mechanism		Diagnostics
EtherCAT® state machine		EtherCAT® system diagnostics
EtherCAT® hardware watchdog		
Emergency messages		Errors are indicated to the master
Diagnostic objects in the CoE object dictionary		Advanced diagnostics, e.g., of I/O errors
	10F1	Error settings
	F100	Axioline Bus Coupler Diag Info
	F101	Axioline bus error counters
	F102	Axioline modules used for synchronization
	F802	Validate module configuration
Diagnosis history object		16 diagnostic messages could not be stored
	10F3	Diagnosis history

17.2 EtherCAT® state machine

An error is indicated as follows:

– Error bit in the “AL status” register is set.
– An error code is written in the “AL status code” register by the slave.

The following codes are implemented on the bus coupler:

AL Status Code [hex]	Meaning
0000	No error: There is no error.
0011	Invalid requested state change: The state change requested is invalid.
0012	Unknown requested state: The state requested does not exist.
0016	Invalid mailbox configuration: Error when configuring the SyncManager for mailbox communication.
001B	SyncManager watchdog: The hardware watchdog which monitors the SyncManager process data has expired.
001D	Invalid output configuration: Error in the SyncManager configuration for output process data.
001E	Invalid input configuration: Error in the SyncManager configuration for input process data.
0028	SyncMode not supported: There is no module in the Axioline F station that supports local bus synchronization.

17.3 Emergency messages

Emergency messages are an unverified service based on CoE. As such, all errors can be indicated to the master by the slave, taking the form of messages which are specified in ETG.1000.6.

Detail of Axioline F bus and I/O errors on a CoE emergency message:

CoE emergency message	2 bytes	1 byte	5 bytes			
	Error code	Error reg	Data			
Axioline F bus errors	2 bytes	1 byte	2 bytes	2 bytes		1 byte
	1000_{hex}	80_{hex}	Slot number	Error code		0
Axioline F I/O errors	2 bytes	1 byte	2 bytes	1 byte	1 byte	1 byte
	Error code	80_{hex}	Slot number	Location	Priority	0

CoE emergency message

Error code (hex)	Meaning
00xx	Error reset or no error
10xx	Generic error
20xx	Current
21xx	Current, device input side
22xx	Current inside the device
23xx	Current, device output side
30xx	Voltage
31xx	Mains voltage
32xx	Voltage inside the device
33xx	Output voltage
40xx	Temperature
41xx	Ambient temperature
42xx	Device temperature
50xx	Device hardware
60xx	Device software
61xx	Internal software
62xx	User software
63xx	Data set
70xx	Additional modules
80xx	Monitoring
81xx	Communication
82xx	Protocol error
8210	PDO not processed due to length error
8220	PDO length exceeded
90xx	External error
A0xx	ESM transition error
F0xx	Additional functions
FFxx	Device specific

The errors which could occur in the Axioline F system are separated into two groups with different message designs.

Axioline F I/O errors

For the error codes for Axioline F I/O errors, please refer to the data sheets for the I/O modules.

Axioline F bus errors

The error codes for Axioline F bus errors have the emergency error code 1000_{hex} (generic error) as standard.

The Axioline F error code is displayed in the “Emergency message” data area.

For the meaning of the error codes for the Axioline F bus errors and Axioline F I/O errors, please refer to the AXL F SYS DIAG user manual.

17.4 Diagnosis history $10F3_{hex}$

The object $10F3_{hex}$ is implemented as a ring memory in Overwrite mode. The last 16 diagnostic messages are always stored; older messages are deleted.

The error codes of the Axioline F bus and I/O errors are stored in the object's diagnostic messages.

The following table shows the design of a diagnostic message from the Axioline F bus coupler for EtherCAT® as well as detailing specific Axioline F information.

Index (hex)	Sub-index	Object name	Data type	Length	Rights	Meaning
10F3		Diagnosis history	Record			Diagnostic statistics
	01	Maximum messages	Unsigned 8	1	R	Maximum number of messages
	02	Newest message	Unsigned 8	1	R	Newest message
	03	Newest acknowledged message	Unsigned 8	1	R/W	Newest acknowledged message
	04	New message available	Bit	0.1	R	New message present
	05	Flags	Unsigned 16	2	R/W	Setting for the behavior of the object. See ETG.1020

17.5 Diagnostic objects in the CoE object dictionary

The Diagnosis History Object enables a diagnosis station-wide.

For module-specific diagnostics, the module diagnostics objects (PDI object 0018_{hex}) are displayed in the CoE object dictionary of the bus coupler (CoE objects $A000_{hex}$ to $A3F0_{hex}$).

18 Firmware update

It is possible to carry out a firmware update via EtherCAT®.

The File Access over EtherCAT® (FoE) mechanism is used for this, which is provided via your engineering system.

For detailed instructions for the firmware update with TwinCAT®, please refer to application note AH EN FIRMWARE UPDATE AXL F BK EC.

The application note can be downloaded at phoenixcontact.net/products.

Changes in the firmware versions

Firmware 1.10

Full implementation of DC Synchronous mode

Addition of the following CoE objects (hex):

10F1	Error settings
10F8	Timestamp
F100	Axioline Bus Coupler Diag Info
F101	Axioline bus error counters
F102	Axioline modules used for synchronization
F800	Endian settings
F801	Leave OP on Axioline busfail
F802	Validate module configuration
F803	Axioline F bus cycle time

Modified object

10F3	Diagnosis history

The data for object $F100_{hex}$ is additionally provided in the cyclic input data of the Axioline F station (see also “Process data of the bus coupler”).

NOTE: Access to incorrect data when using a project that has not been adapted

The data of object $F100_{hex}$ is mapped in the process image before the IN process data of the first Axioline F module.
If an existing project is used without adapting it, you will access incorrect data due to the shift of the IN process data.
Therefore, adapt an existing project accordingly.

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